

What is claimed is:

1. A method for producing a deep trench capacitor in a semiconductor substrate, comprising:

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providing a first trench in the semiconductor substrate;

oxidizing the semiconductor substrate in the first trench for providing an oxidized silicon layer;

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depositing a conformal aluminium-oxide layer in the first trench;

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removing horizontal regions of the deposited aluminium-oxide layer and the oxidized silicon layer;

providing a second trench underneath the first trench;

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increasing a width of the second trench to a widened second trench for providing a bottle structure;

depositing a dielectric layer in the widened second trench; and

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filling the widened second trench with a conductive filling.

2. The method according to claim 1, wherein after increasing the width of the second trench to the widened second trench a  
30 doping the semiconductor substrate in the widened second trench is provided for providing a first electrode.

3. The method according to claim 1, wherein after increasing the width of the second trench to the widened second trench  
35 or after doping the semiconductor substrate in the widened second trench, further comprising:

depositing a rugged polysilicon layer in the widened second trench.

4. The method according to claim 3, wherein the depositing of  
5 the rugged polysilicon layer in the widened second trench is  
provided by a hemispherical grain polysilicon deposition  
process.

5. The method according to claim 1, wherein depositing a  
10 dielectric layer comprises:  
depositing a first silicon nitride layer; and  
oxidation the first silicon nitride layer for providing  
the dielectric layer.

15 6. The method according to claim 1, wherein the conductive  
filling is a polysilicon filling.

7. The method according to claim 1, wherein the aluminium-  
oxide layer is a  $\text{Al}_2\text{O}_3$ -layer.

20 8. The method according to claim 1, wherein increasing the  
width of the second trench to the widened second trench for  
providing the bottle structure is provided by a wet etching  
process.

25 9. The method according to claim 1, wherein the increasing  
the width of the second trench to the widened second trench  
for providing the bottle structure is provided by a reactive  
ion etching process.